TRB TRANSPORTATION RESEARCH BOARD OF THE NATIONAL ACADEMIES
Transportation Research Board 94th Annual Meeting
January 11–15, 2015 ▪ Washington, D.C.

Paper No. 15-2586

Effect of mobile phone distraction on car-following behaviour

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CARRS

RESEARCH OBJECTIVE

Investigate the effect of hands-free and handheld mobile phone conversation on car-following (CF) behaviour.

PREVIOUS FINDINGS

Impact of mobile phone use while driving

Increase Reaction time | Increase Spacing |
Decrease Speed | Increase Speed variability |
Increase lane deviation | Increase Speed recovery time after breaking


Queensland drivers fined $25,000 a day for using mobile phones behind the wheel
Courier Mail

28,700 fines in 2013

To date, few studies have attempted to document the risk of mobile phone use in car-following situation. Our understanding on this important issue remains elusive.

METHODOLOGY

Driving simulator experiment with different driving conditions

Baseline (no phone conversation) | Hands-free phone conversation | Handheld phone conversation

Comparison of car-following behaviour among base, hands-free and handheld phone conversation driving

GEE model of driver's time headway selection

EXPERIMENTAL SETUP

CARRS-Q Advanced Driving Simulator

- A complete Holden Commodore vehicle
- 1800 driver's view with three front-view projectors
- Simulated rear view mirror images
- 6 degree-of-freedom motion base
- Surround sound for engine and environment noise
- Data are recorded at rates up to 20 Hz

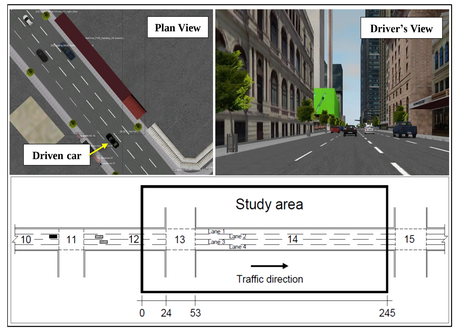

Participants: 32 participants (16 males & 16 females) having age between 18-26 years.

Participants drove the Simulator in three phone conditions:

- **Baseline:** No phone conversation while driving
- **Hands-free:** Engaged in phone conversation through a hands-free device while driving
- **Handheld:** Engaged in phone conversation through a handheld mobile phone

DRIVING ROUTE

- The car-following event was occurred along urban roads where the speed limit was 40 km/h.
- When the driven vehicle (black car) stops at the signalized intersection 11, two pre-programmed lead vehicles (grey cars) appear on the two lanes of road section 12. Lane 1 and 4 was blocked by parked vehicles.
- When the spacing between the subject and the lead vehicle reached 60m, the speed of both lead vehicles increased up to 20km/h. When the spacing was 30m or less, lead vehicles increased the speed to 35km/h and maintained that speed.
- The signal at intersection 13 was kept green to provide uninterrupted flow from section 12 to 14.



IMPACTS OF PHONE CONVERSATION ON DRIVING

Speed decreased

Average speed was 5.5% slower in handheld and 3.5% slower in hands-free phone conversation while driving compared to the baseline (no phone conversation while driving).

Spacing increased

Average spacing was 17.4% higher in handheld and 8.1% higher in hands-free compared to baseline.

Time headway increased

Compared to baseline condition the average time headway was 28.0% higher in handheld and 13.5% higher in hands-free phone condition.

Fluctuation in speed increased

Fluctuation in speed was 35.9% higher when driving with handheld phone conversation compared to baseline.

Fluctuation in spacing increased

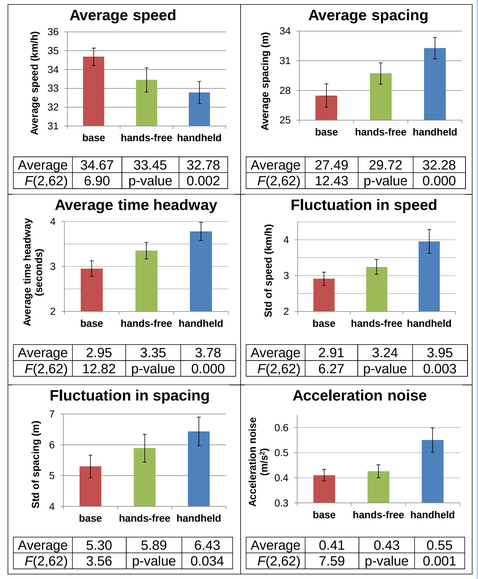
Fluctuation in spacing was 21.5% higher in handheld phone condition compared to baseline.

Acceleration noise increased

Acceleration noise was 33.9% higher in handheld phone condition compared to baseline.

Hands-free vs. handheld condition

Significant difference is found for average spacing, average time headway, fluctuation in speed and acceleration noise.



	base	hands-free	handheld
Average	34.67	33.45	32.78
$F(2,62)$	6.90	p-value	0.002

	base	hands-free	handheld
Average	27.49	29.72	32.28
$F(2,62)$	12.43	p-value	0.000

	base	hands-free	handheld
Average	2.95	3.35	3.78
$F(2,62)$	12.82	p-value	0.000

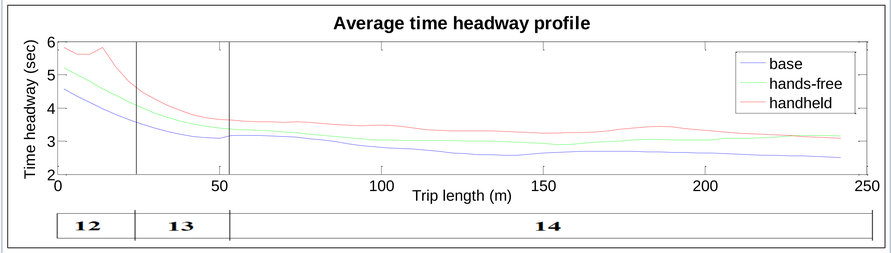
	base	hands-free	handheld
Average	2.91	3.24	3.95
$F(2,62)$	6.27	p-value	0.003

	base	hands-free	handheld
Average	5.30	5.89	6.43
$F(2,62)$	3.56	p-value	0.034

	base	hands-free	handheld
Average	0.41	0.43	0.55
$F(2,62)$	7.59	p-value	0.001

The *F*-statistic is calculated using repeated measures ANOVA test which shows whether the use of mobile phone while driving has any significant effect on the selected variable.

The difference in variable values among the baseline, hands-free and handheld conditions follows a continuous trend along the roadway. As an example only the time headway profile is shown here.



GEE ANALYSIS

- Compared to driving with no phone conversation, drivers keep 0.33 sec more time headways when engaged in hands-free phone conversation and 0.75 sec more time headways when engaged in handheld phone conversation while driving.
- Female drivers keep 0.68 sec less time headways than male drivers in similar CF situations.
- Provisional licence holders (inexperienced drivers) keep 0.81 sec more time headways than open licence holders (experienced drivers) .
- According to this model, a female with open driving license will keep the shortest time headway while a male driver with provisional licence will keep the longest time headway.

$$\textit{Average time headway} = b_0 + b1 * \textit{phone condition} + b2 * \textit{average speed difference} + b3 * \textit{gender} + b4 * \textit{licence type}$$

Correlation structure = exchangeable; Link = identity.

Variable	Estimate	Pr(>|W|)
(Intercept)	3.7653	0.000***
Phone = hands-free	**0.331**	0.011*
Phone = handheld	**0.746**	0.000***
Mean ΔV	**0.286**	0.000***
Gender = female	**-0.677**	0.017*
License = Provisional	**0.814**	0.007**
Scale parameter	0.614	
Correlation parameter	0.503	
QIC	-30.8	
Marginal R-square	0.49	
Number of clusters	32	
Maximum cluster size	3	

CONCLUSIONS

- Overall, drivers maintained lower speeds, larger vehicle spacings, and longer time headways when engaged in phone conversations compared to baseline condition. This finding indicates risk-compensatory behaviour of distracted drivers.
- The reduction in speed and increase in vehicle spacing could reflect drivers' attempts to compensate for the increased risk associated with the mobile phone conversations, or could be an artefact of the distraction itself. If it reflects risk compensation, there is insufficient evidence to assess whether the reduction in crash risk would offset the increased crash risk arising from distraction. Other evidence on crash risk while distracted suggests that crash risk overall is increased while distracted, suggesting anecdotally that any observed risk compensation is insufficient to offset objectively measured risk increases arising from cognitive distraction.
- A significant increase in fluctuation in speed, spacing and acceleration/deceleration indicates less consistent control of distracted drivers in maintaining speed and vehicle spacing while following the preceding vehicle.
- Distraction effect was highest when engaged in handheld phone conversation while driving. Holding the phone by hand placed an additional physical demand on the driver, which together with the mental demand, leads to a greater distraction effect between the two phone conversations.
- Beside the distraction effect, the analysis also revealed the gender difference and impact of driving experience in time headway selection in car-following.
- The findings in this study clearly show that drivers behave differently when distracted by phone conversations. Unfortunately, most of the existing car-following models do not consider such impacts on driving.
- Empirical evidence on how distracted driving influences car-following behaviour (e.g., speed, spacing, and time headway selection) revealed in this study can facilitate the improvement of car-following models by incorporating human factors.
- These results should foster a better understanding of the consequence of distracted driving on road crashes, and shed light on the complexity involved with modelling driving behaviour.